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# Original Research

## Evaluation of heart rate variability in hypertensive and normotensive subjects

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***ABSTRACT*:**

**Background:** The autonomic nervous system (ANS) plays a fundamental role in the control of arterial blood pressure and heart rate, and, therefore, may be considered an important pathophysiologic factor in the development of arterial hypertension. The present study was conducted to evaluate heart rate variability in hypertensive patients. **Materials & Methods:** The present study was conducted on 90 hypertensive patients of both genders. Spectral indices of HRV such as total power (TP), normalized low frequency power (LFnu), normalized high frequency power (HFnu), ratio of low frequency power to high frequency power (LF-HF ratio), standard deviation of normal-to-normal RR intervals (SDNN), root mean square successive difference (rMSSD) and the proportion of NN50 to the total number of NN intervals (pNN50) were assessed. **Results:** Group I had 50 males and 40 females while group II had 46 males and 44 females. SDNN (ms) in group I was 158.2 and in group II was 144.5, rMSSD (ms) in group I was 42.5 and in group II was 39.5, pNN50 in group I was 14.4 and in group II was 11.8. LFnu in group I was 74.2 and in group II was 88.1, HFnu in group I was 56.4 and in group II was 36.4, LF/HF ratio in group I was 2.68 and in group II was 3.86. **Conclusion:** HRV can be used as a routine screening test to predict the future risk of hypertension at an earlier stage. There is an increased sympathetic activity and a decreased vagal tone associated with hypertension. Hypertensive elderly patients present decreased heart rate variability and decreased parasympathetic modulation when compared to normotensive elderly.

**Key words:** Heart rate variability, sympathetic, Hypertension

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### INTRODUCTION

The autonomic nervous system (ANS) plays a fundamental role in the control of arterial blood pressure and heart rate, and, therefore, may be considered an important pathophysiologic factor in the development of arterial hypertension[1]. Currently, the status of autonomic action of the heart may be known through the study of heart rate variability. Heart rate varies per beat as a consequence of the constant adaptations promoted by the ANS to maintain cardiovascular system balance. These alterations may be assessed through the variations in R-R intervals, therefore, constituting the heart rate variability[2]. The integration between the sympathetic and parasympathetic modulations determines heart rate variability[3]

Blood pressure is maintained physiologically by multiple regulatory mechanisms such as neural control, hormonal control and local control mechanism. Among them, neural control by Autonomic nervous system (ANS) is the most important regulatory mechanism of blood pressure. Though hypertension is a multifactorial disease, ANS dysfunction is an important factor in the development and progression of hypertension.[1]

Hypertension is defined as a persistent elevated blood pressure of ≥140/90 mmHg. It is one of the most prevalent diseases worldwide. The prevalence of hypertension in South Indian population is around 22.1%. There are many modifiable risk factors underlying hypertension such as increased body weight, reduced physical activity, high salt intake, alcohol consumption and low potassium intake. Hypertension is a major risk factor for many cardiovascular diseases

like coronary artery disease, stroke, heart failure and end-stage renal disease. It has been estimated that hypertension accounts for 6% of death world wide. Thus, primary prevention of hypertension may reduce the overall risk of cardiovascular diseases.

Heart rate variability (HRV) has emerged as a practical, noninvasive tool to quantitatively investigate cardiac autonomic dysregulation in hypertension.[4] Studies have reported decreased HRV among hypertensives and that the relation between blood pressure and HRV is present across a wide range of blood pressures.[5] Data from the Framingham cohort and a subset of the Atherosclerosis Risk in Communities (ARIC) cohort suggest that individuals with decreased HRV have an increased risk of developing hypertension, although results are inconsistent across measures of HRV and sex. It is also unknown to what degree hypertensives and normotensive experience similar declines in HRV. Thus, although the autonomic nervous system is involved in the regulation of blood pressure, the temporal sequence linking hypertension and HRV is unclear.[6] The present study aimed at analyzing heart rate variability in hypertensive and normotensive subjects.

## MATERIALS & METHODS

The present study was conducted in the Department of Physiology and Anatomy of Sakshi Medical College, Guna, Madhya Pradesh, India. After obtaining clearance from the Institutional ethical committee 90 hypertensive male and female patients were recruited in study. Equal number of normotensive subjects was also included. Written consent was obtained from all participants before the commencement of study.

Demographic characters of all study participants were recorded. A thorough clinical examination was done. In all subjects, blood pressure measurement was done following auscultatory method. Group I comprised of hypertensive patients and group II had normotensive subjects. The criteria for diagnosing hypertension were BP ≥140/90 mmHg based on the average of 3 consecutive readings at an interval of 3 weeks. Subjects with blood pressure values of 100-119/60-79 mm Hg were recruited as normotensive.

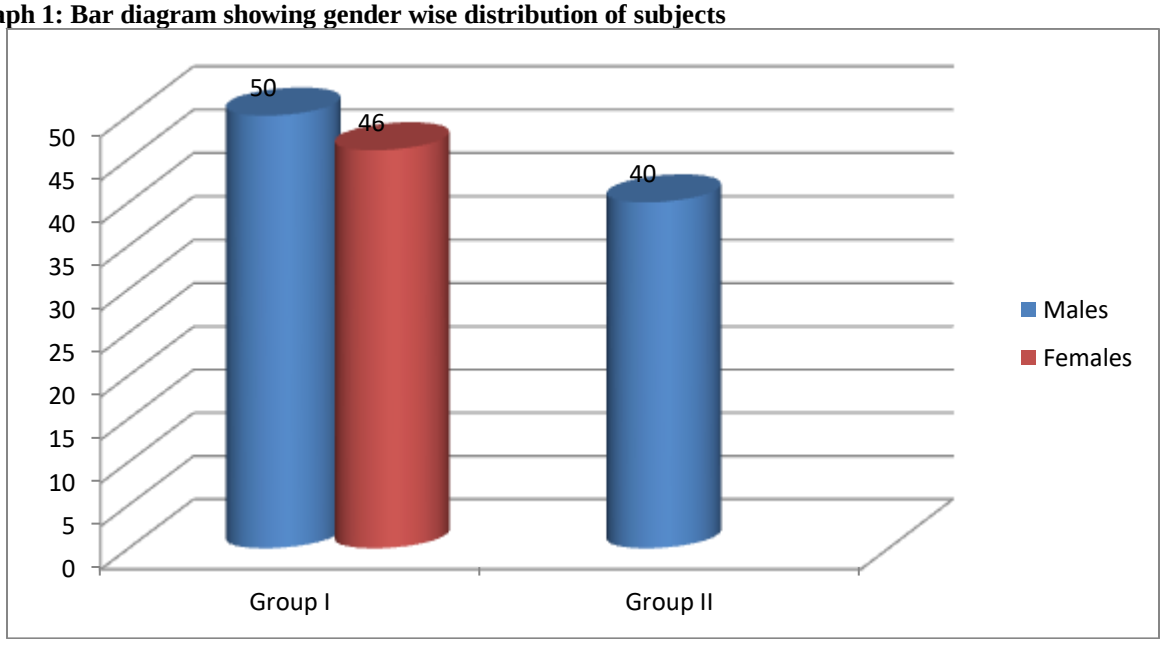
Spectral indices of HRV such as total power (TP), normalized low frequency power (LFnu), normalized high frequency power (HFnu), ratio of low frequency power to high frequency power (LF-HF ratio), standard deviation of normal-to-normal RR intervals (SDNN), root mean square successive difference (rMSSD) and the proportion of NN50 to the total number of NN intervals (pNN50) were assessed.

**Statistical analysis:**

The data was analyzed using SPSS version 17. All the HRV measures were expressed as mean±SD. Unpaired "t" test was used to compare the values between normotensive and hypertensive groups.

## RESULTS

**Graph 1: Bar diagram showing gender wise distribution of subjects**




Graph I shows that group I had 50 males and 40 females while group II had 46 males and 44 females.

**Table I: Estimation of time domain**

| Time domain | Group I | Group II | P value |
|---|---|---|---|
| SDNN (ms) | 158.2 | 144.5 | 0.01 |
| rMSSD (ms) | 42.5 | 39.4 | 0.04 |
| pNN50 | 14.4 | 11.8 | 0.01 |

Table I shows that SDNN (ms) in group I was 158.2 and in group II was 144.5, rMSSD (ms) in group I was 42.5 and in group II was 39.5, pNN50 in group I was 14.4 and in group II was 11.8.

**Table II: Determination of frequency domain**

| Time domain | Group I | Group II | P value |
|---|---|---|---|
| LFnu | 74.2 | 88.1 | 0.02 |
| HFnu | 56.4 | 36.4 | 0.01 |
| LF/HF ratio | 2.68 | 3.86 | 0.01 |

Table II shows that LFnu in group I was 74.2 and in group II was 88.1, HFnu in group I was 56.4 and in group II was 36.4, LF/HF ratio in group I was 2.68 and in group II was 3.86.

## DISCUSSION

Currently, the status of autonomic action of the heart may be known through the study of heart rate variability.[7,8] Heart rate varies per beat as a consequence of the constant adaptations promoted by the ANS to maintain cardiovascular system balance. These alterations may be assessed through the variations in R-R intervals, therefore, constituting the heart rate variability.[9] The integration between the sympathetic and parasympathetic modulations determines heart rate variability. As a research tool, assessment of heart rate variability has provided a better understanding of the participation of the ANS in different physiological and pathological situations of the cardiovascular system. The assessment of heart rate variability has stimulated a large number of observations, indicating the potential value of that approach in the diffusion of knowledge about the alterations in the mechanisms of blood pressure control involved in hypertension.[10] The present study was conducted to assess heart rate variability in hypertensive patients.

In present study, group I had 50 males and 40 females while group II had 46 males and 44 females. Xie et al[11] conducted a study to assess the sympatho-vagal balance by analysing the HRV changes in hypertensive individuals. The study was conducted on 30 normotensive and 30 hypertensive subjects (BP≥140/90 mm Hg, according to JNC-7 classification). Results showed significantly reduced HFnu ($p<0.05$), SDNN ($p<0.05$), rMSSD ($p<0.05$) and pNN50 ($p<0.05$) in hypertensive individuals. LFnu and LF-HF ratio was significantly increased ($p<0.05$) in hypertensive individuals.

We found that SDNN (ms) in group I was 158.2 and in group II was 144.5, rMSSD (ms) in group I was 42.5 and in group II was 39.5, pNN50 in group I was 14.4 and in group II was 11.8. LFnu in group I was 74.2 and in group II was 88.1, HFnu in group I was 56.4 and in group II was 36.4, LF/HF ratio in group I was 2.68 and in group II was 3.86.

Menezes et al[12] conducted a study comprised 286 patients diagnosed with arterial hypertension (AH) for the first time and divided into 4 groups according to diastolic blood pressure (DBP) levels: group A - DBP<90 mmHg; group B - DBP 90-99 mmHg; group C – DBP 100-109 mmHg; group D - DBP>110 mmHg. Group A (110 healthy individuals) and group C (79 patients with moderate AH) underwent 24-hour Holter-ECG with analysis of heart rate variability in time domain (TD) and frequency domain (FD). The group C patients were treated with ACE inhibitors for 3 months, and, after this period, they underwent a new 24-hour Holter- ECG study for assessing heart rate variability, the values being compared with those of normotensive individuals. The SDNN and PNN50 parameters (TD), and the LF spectrum (FD) were significantly different in the 2 groups, with clearly reduced values in hypertensive individuals ($P<0.05$). Group C patients, after treatment with ACE inhibitors, showed a recovery in all variables of heart rate variability, achieving values close to those of normotensive individuals.

de Andrade PE et al compared the cardiac autonomic modulation between healthy elderly and hypertensive elderly by involving 80 elderly people comprised of 40 healthy elderly and 40 elderly (HBP). Results showed that time domain the Mean RR index presented a HAS increase $832.35 \pm 104.46$ ms vs control $782.73 \pm 112.78$ ms ($p = 0.040$). In the SDNN, there was a 58.35ms decrease vs the SAH 43.15 ms ($p = 0.030$). In the frequency domain, HF decreased control 247.00 ms2 vs HAS 157.00 ms2 ($p = 0.002$). In the geometric, the TINN and SD2 in the HAS group decreased in relation to the control from

$203.38 \pm 80.26$ ms to $161.83 \pm 53.25$ ms ($p = 0.018$) and from 71.95 ms to 59.40 ms ($p = 0.051$). The mean SD1/SD2 ratio showed an increase between the Control and SAH groups from $0.22 \pm 0.10$ to $4.09 \pm 1.18$ and there was a statistical difference ($p = 0.001$). They suggested that Hypertensive elderly patients present decreased heart rate variability and decreased parasympathetic modulation when compared to normotensive elderly.[15]

Schroeder et al (2003) showed that the HRV-blood pressure association extended to low blood pressures and is stronger among lower blood pressures than among blood pressures in the hypertensive range. This finding was significant, because it showed that the association between blood pressure and HRV is continuous, without a marked threshold and with important effects even at relatively low blood pressures.[16]

We suggested that further prospective studies with longitudinal design would be performed to investigate HRV in the early stages of hypertension

## CONCLUSION

HRV can be used as a routine screening test to predict the future risk of hypertension at an earlier stage. Hypertensive elderly patients present decreased heart rate variability and decreased parasympathetic modulation when compared to normotensive elderly. There is an increased sympathetic activity and a decreased vagal tone associated with hypertension.

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